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FINAL REPORT
JULY 1993

REPORT NO. 93-08

TRANSPORTABILITY TEST OF
EXTRUDED ALUMINUM
CONTAINERS SECURED WITH
U.S. AIR FORCE (USAF) CHAINS IN
A SIDE-OPENING CONTAINER



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Prepared for:
U.S. Army Defense Ammunition
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ATTN: SMCAC-DET
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VALIDATION ENGINEERING DIVISION
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<p>The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Transportation Engineering Division (SMCAC-DET), to test U.S. Air Force (USAF) chain tiedown assemblies. Tests were conducted with eight extruded containers loaded in a side-opening container restrained by the USAF chain tiedown assemblies. During the first test, the chain assembly tensioning devices broke. During the second test, the tiedown fittings in the side-opening container floor failed. Using USAF chain tiedown assemblies in side-opening containers for rail shipment is not recommended.</p>					
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**U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
VALIDATION ENGINEERING DIVISION
SAVANNA, IL 61074-9639**

REPORT NO. 93-08

**TRANSPORTABILITY TEST OF EXTRUDED ALUMINUM CONTAINERS SECURED
WITH U.S. AIR FORCE (USAF) CHAINS IN A SIDE-OPENING CONTAINER**

JULY 1993

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PART 1

INTRODUCTION

A. **BACKGROUND.** The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Transportation Engineering Division (SMCAC-DET), to test U.S. Air Force (USAF) chain tiedown assemblies. Tests were conducted with eight extruded containers loaded in a side-opening container restrained using the USAF chain tiedown assemblies.

B. **AUTHORITY.** This test was conducted IAW mission responsibility delegated by U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL 61299-6000. Reference is made to Change 4, 4 October 1974, to AR 740-1, 23 April 1971, Storage and Supply Operations; AMCCOMR 10-17, 31 August 1991, Mission and Major Functions of U.S. Army Defense Ammunition Center and School.

C. **OBJECTIVE.** The objective of these tests is to validate the concept of shipping CNU-310/E containers in a commercial side-opening ISO container secured with chains and tensioning devices compatible with the 463L pallet. Eight CNU-310/E containers were chained inside the side-opening container and rail impacted.

D. **CONCLUSION.** The first test was performed on 3 March 1993 and resulted in failure of the chain tensioning device at 4 mph. The device was replaced and the tiedown ring in the container failed after a 6 mph impact. A second test was performed on 19 July 1993 with the chains and tensioning devices tied shut. The chains and tensioning devices held. At 8.1 mph in the reverse direction a D-ring in the floor of the container failed.

E. RECOMMENDATIONS. The chains and tensioning devices appeared to have sufficient strength to hold eight CNU-310/E containers in a side-opening commercial ISO container; however, the various containers used for these tests do not have tiedown provisions with sufficient strength to safely secure the load. Additional tests should be performed to determine the strength of the tiedown provisions. These strengths should be compared to the procurement requirements and MIL-STD-209H, Military Standard Slings and Tiedown Provisions for Lifting and Tying Down Military Equipment.

PART 2

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PART 3

TEST PROCEDURES

A. The following test procedures were extracted from TP-91-01, Transportability Testing Procedures, July 1991, for chassis-mounted container transportation by truck on a railcar.

B. The CNU-310/E containers were loaded into a USAF side-opening container and secured with the chains and tensioning devices supplied. The loaded container was mounted on a container chassis and then loaded onto a Trailer-on-flatcar (TOFC) for rail impact testing.

C. Tests for the loaded side-opening container are as follows:

- 1. Rail impact (Test Method No. 1).**
- 2. Road hazard course (Test Method No. 2).**
- 3. Road trip (Test Method No. 3).**
- 4. Road hazard course (Test Method No. 2).**
- 5. Washboard course (Test Method No. 6).**

D. The test methods are as follows:

1. Test Method No. 1 (Rail Impact Test). The container and chassis was positioned on a flatcar. The chassis was secured to the stanchion on the friction draft gear TOFC railcar. Equipment needed to perform the test included the specimen (hammer) car, five empty railroad cars connected together to serve as the anvil, and a railroad locomotive. The anvil cars were positioned on a level section of track with air and hand brakes set and with the draft gears

compressed. The locomotive unit pulled the specimen car several hundred yards away from the anvil cars, then pushed the specimen car toward the anvil at a predetermined speed, and then disconnected from the specimen car approximately 50 yards away from the anvil cars, which allowed the specimen car to roll freely along the track until it struck the anvil. This constituted an impact. Impacting was accomplished at 4, 6, and 8.1 mph in one direction and at a speed of 8.1 mph in the opposite direction. The 4 and 6 mph impact speeds were approximate; the 8.1 mph speed was a minimum. Impact speeds were determined by using an electronic counter to measure the time required for the specimen car to traverse an 11-foot distance immediately prior to contact with the anvil cars (see Figure 1, page 3-4).

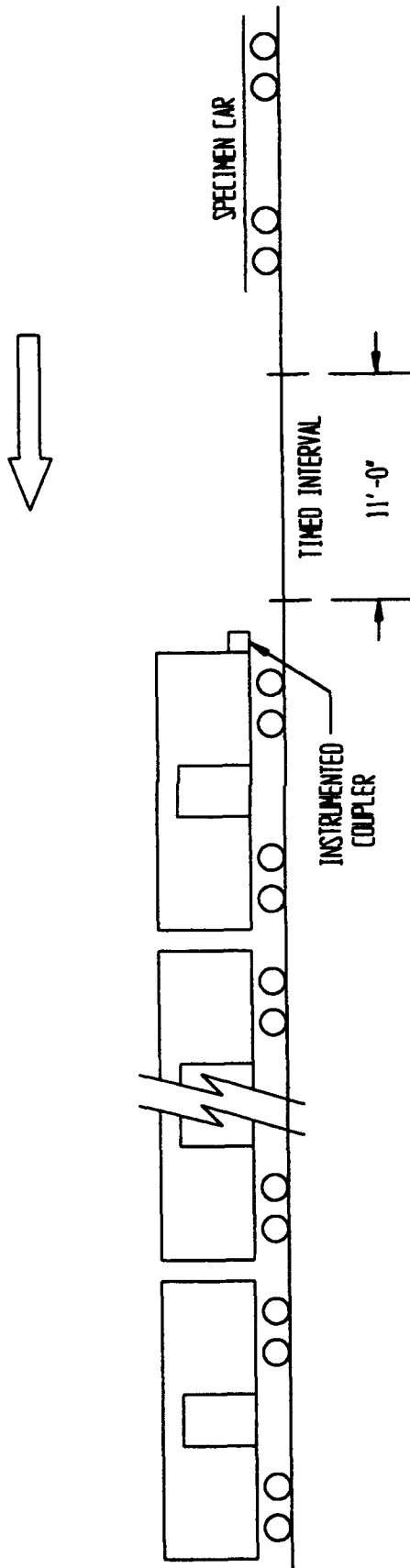
2. Test Method No. 2 (Road Hazard Course). This method required the chassis-mounted container be pulled over the 200-foot-long segment of concrete-paved road which consists of two series of railroad ties projecting 6-inches above the level road surface. The container traversed this course two times. The road hazard course is constructed as shown in Figure 2, page 3-5.

3. Test Method No. 3 (Road Trip). The container and chassis was pulled for a distance of 30 miles over a combination of roads surfaced with gravel, concrete, or asphalt. The test route included curves, corners, railroad crossings, cattle guards, and stops and starts. The chassis and container traveled at the maximum speed suitable for the particular road being traversed, except as limited by legal restrictions.

4. Test Method No. 4 (Road Hazard Course). This method is a repeat of the procedure used in Test Method No. 2.

5. Test Method No. 5 - (Washboard Course). The chassis-mounted container was pulled over the washboard course at a speed which produced the most violent response in the container. The washboard course is constructed as shown in Figure 3, page 3-5.

ASSOCIATION OF AMERICAN RAILROADS (AAR) STANDARD TEST PLAN

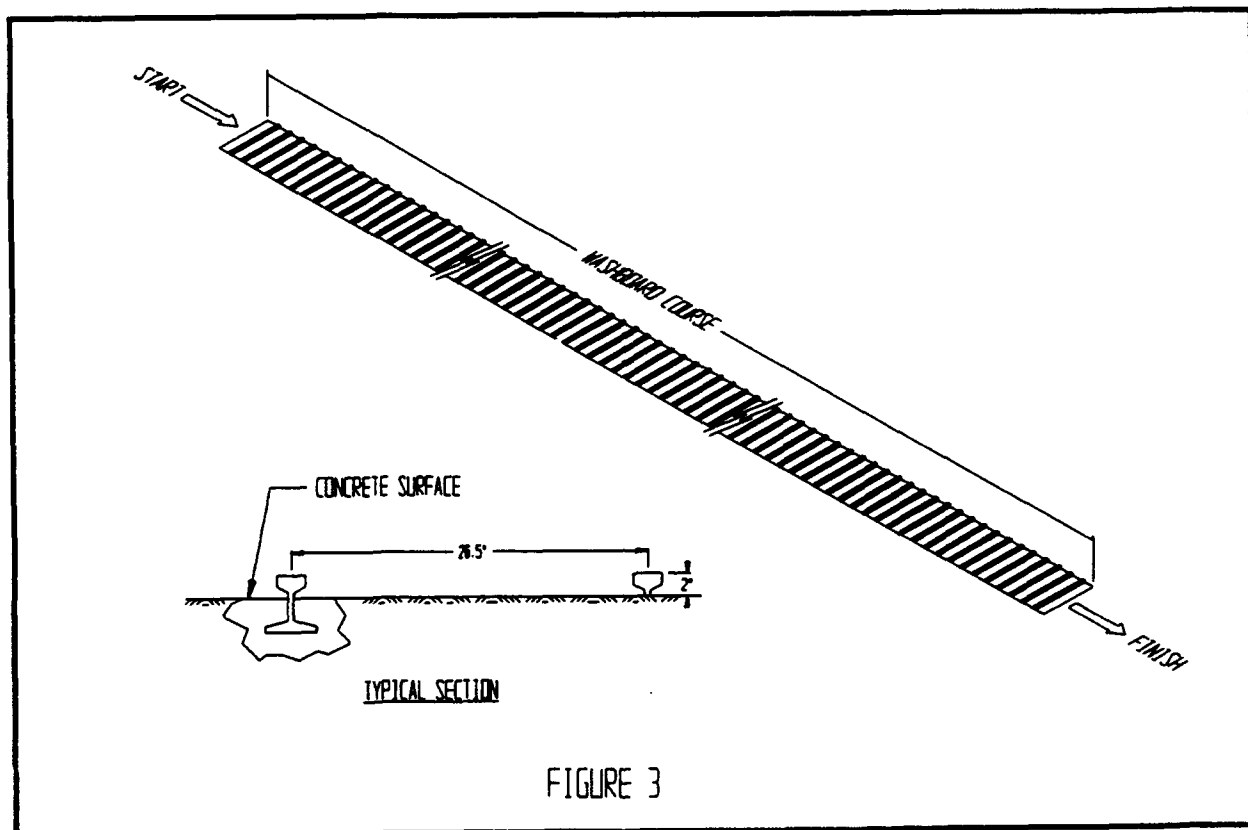
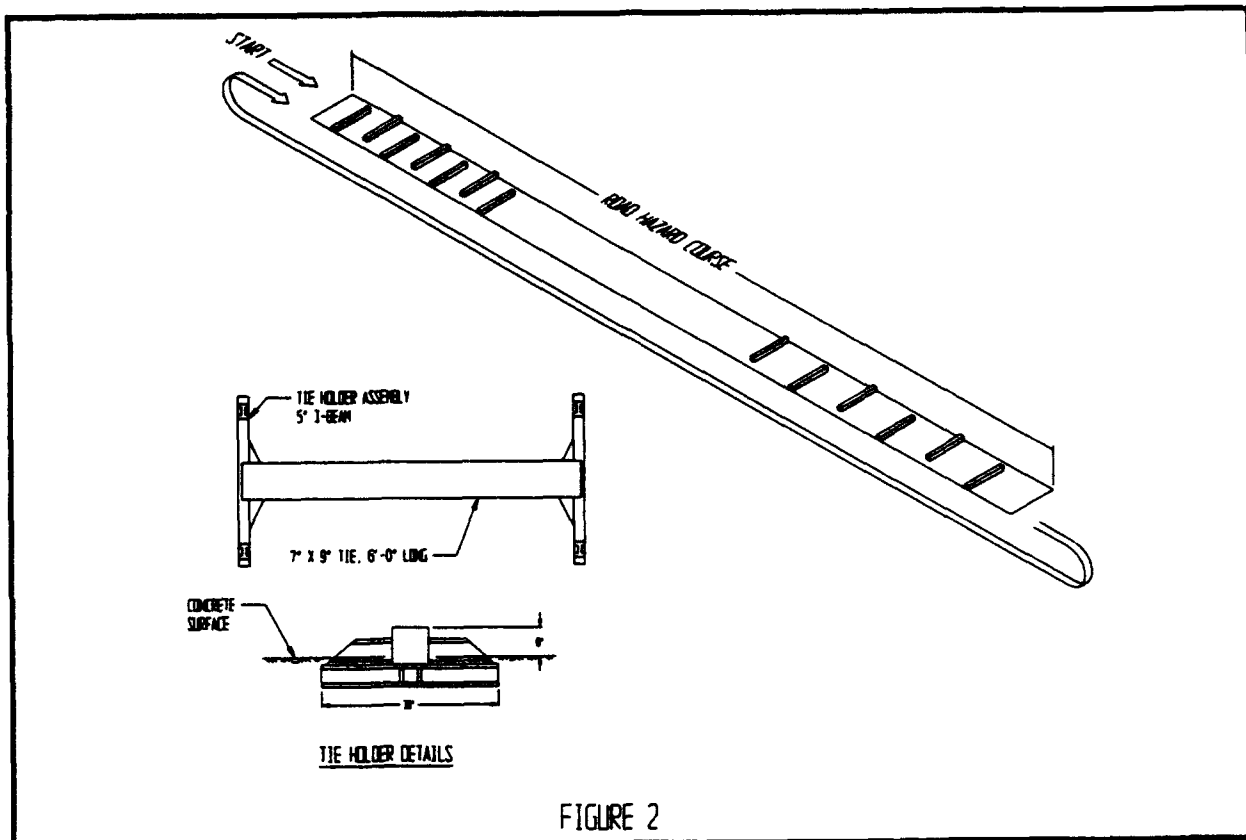


5 BUFFER CARS (ANVIL) WITH DRAFT GEAR
COMPRESSED AND AIR BRAKES IN A SET
POSITION
ANVIL CARS TOTAL WT 250,000 LBS (APPROX)

SPECIMEN CAR
IS RELEASED BY
SWITCH ENGINE TO
ATTAIN: IMPACT NO. 1 @ 4 MPH
IMPACT NO. 2 @ 6 MPH
IMPACT NO. 3 @ 8.1 MPH

THEN THE CAR IS REVERSED AND
RELEASED BY SWITCH ENGINE TO
ATTAIN: IMPACT NO 4. @ 8.1 MPH

FIGURE 1



PART 4

TEST RESULTS

TEST SPECIMEN AND RESULTS

RAIL IMPACT DATA

Test No.: 1

Date: 3 March 1993

Specimen Load: CNU-310/E containers loaded in a side opening container secured with chains and tensioning devices.

TOFC: TTX 154756

Lt. Wt.: 72,000

Chassis No.: 5027

Wt.: 6,500

Container No.: USAF 0354645

Wt.: 6,050

Lading:

Wt.: 11,040

Total Specimen Wt.: 95,590

Buffer Car (five cars) Wt.: 250,000

<u>Impact</u>	<u>End Struck</u>	<u>Velocity</u>	<u>Remarks</u>
1	Forward	4.19	One tensioning device broke which was probably not installed properly. Reinstalled with new device.
2	Forward	6.32	Tensioning device held, tiedown provision in the container failed. Test stopped.

Test No.: 2

Date: 23 July 1993

Specimen Load: CNU 310/E containers loaded in a side-opening container secured with chains and tensioning devices.

TOFC: RTTX 601015

Lt. Wt.: 71,500

Chassis No.: 5027

Wt.: 6,500

Container No.: USAF 0013998

Wt.: 6,050

Lading:

Wt.: 11,040

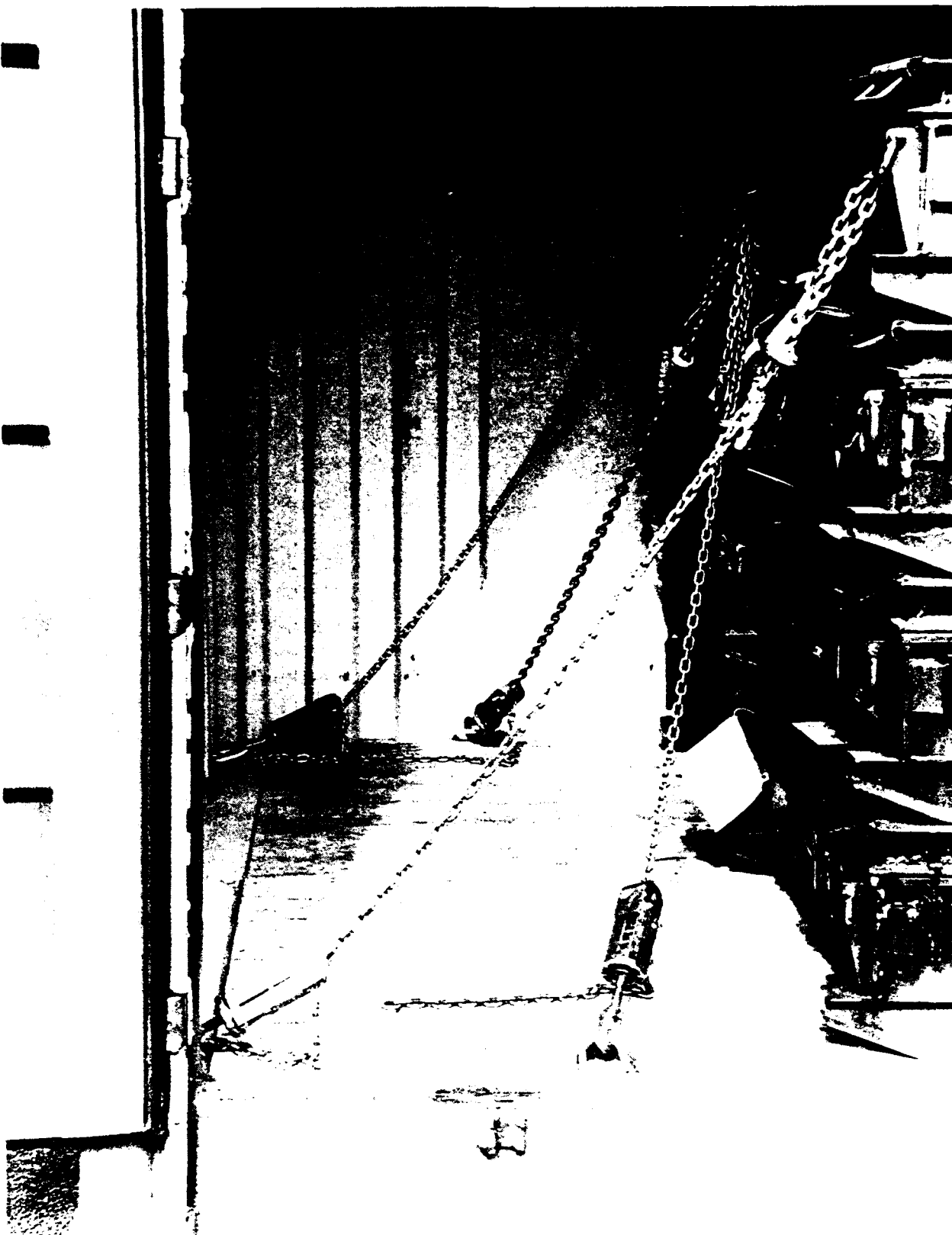
Total Specimen Wt.: 95,590

Buffer Car (five cars) Wt.: 250,000

<u>Impact</u>	<u>End Struck</u>	<u>Velocity</u>	<u>Remarks</u>
1	Forward	4.56	
2	Forward	6.39	
3	Forward	8.52	Chains became loose on the opposite impact end.
4	Aft	8.62	Three container tiedown provisions failed. The chains and tensioning devices were not damaged.

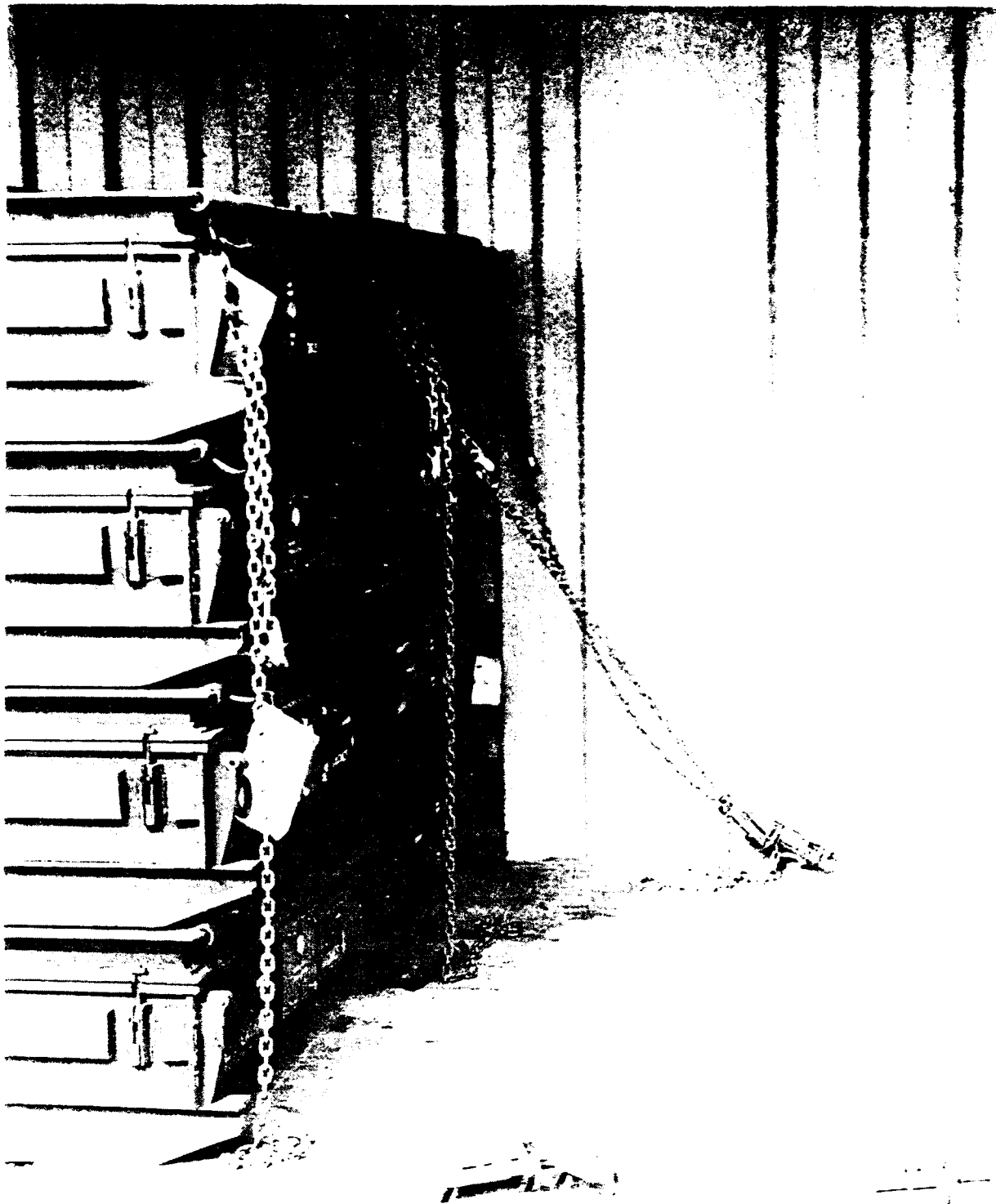
PART 5

PHOTOGRAPHS



U.S. ARMY DEFENSE AMMUNITION CENTER AND
SCHOOL - SAVANNA, IL

A0317-SPN93-106-1136. This photo shows the aft end of a side-opening container loaded with CNU-310/E containers. The chains and tensioning devices are used to secure the load to the container tiedown provisions.



U.S. ARMY DEFENSE AMMUNITION CENTER AND
SCHOOL - SAVANNA, IL

A0312-SPN93-106-1137. This photo shows three chain assemblies that failed after a rail impact speed of 8.1 mph in reverse. Two chains pulled from the tensioning device and one pulled the tiedown provision from the floor.



U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

A0317-SPN93-106-1142. This photo shows the container tiedown provision that failed at an 8.1mph impact speed. Note the partially welded D-ring retainer.



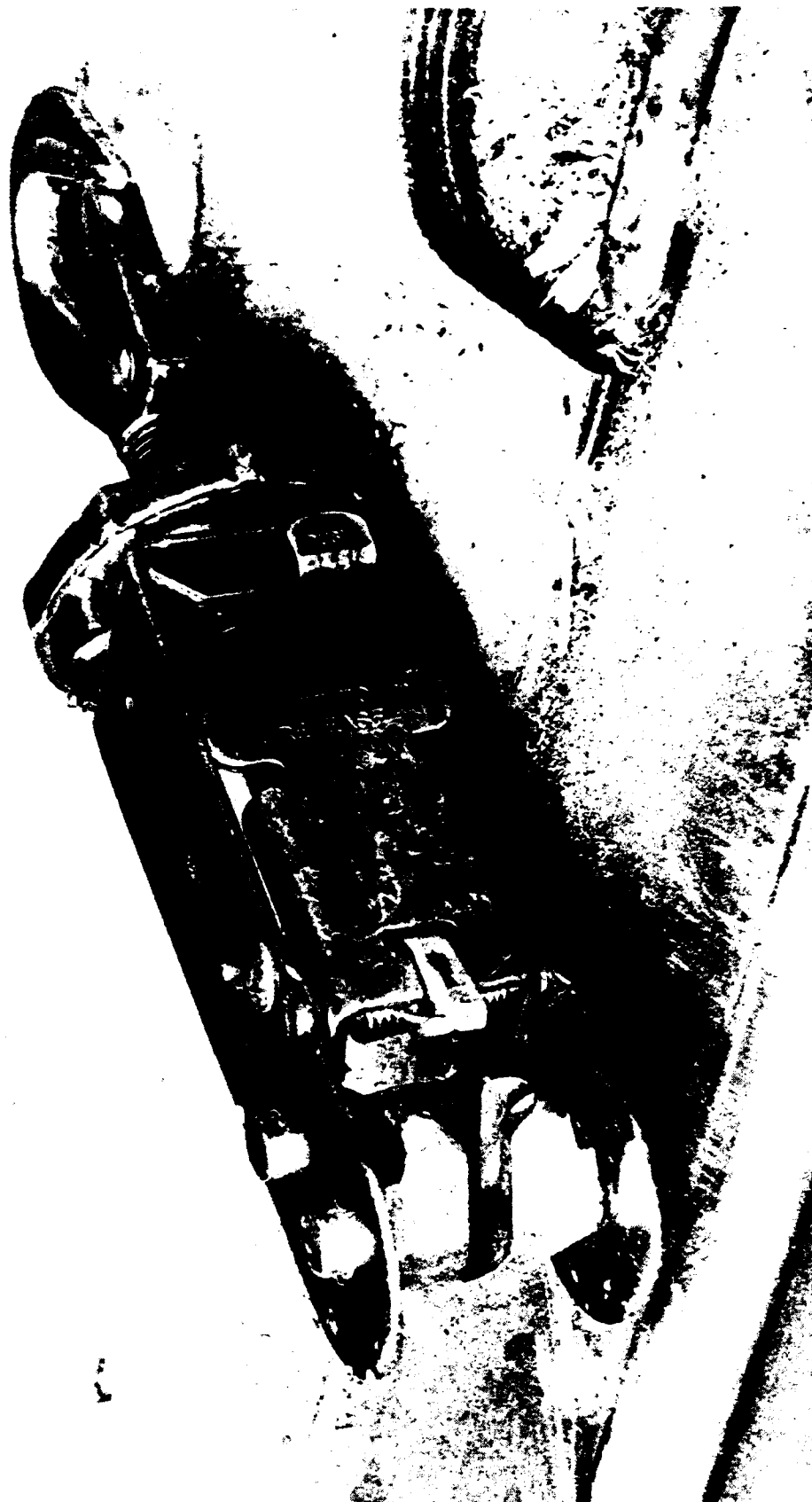
U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

A0317-SPN93-106-1143. This photo shows the former D-ring. Note the butt weld at the ends of the ring was not 100 percent effective.



U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

A0317-SPN93-106-1141. This photo shows two chain tensioning devices. The top device is in operable condition. The lower device failed to hold. Note the rounded edge on the chain lock assembly.



U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

A0317-SPN93-106-1138. This photo shows a closeup view of a chain tensoning device that failed to secure a load of CNU-310/E containers in a side-opening container. The chain link holder casting stop and lock feature deformed during a rail impact.